Summary Report of Geologic Resources Evaluation Workshop
Lake Roosevelt National Recreation Area
September 10, 2002

Introduction

The Geologic Resources Evaluation (GRE, formerly Geologic Resource Inventory) workshop for Lake Roosevelt National Recreation Area (LARO) was held in Seattle, Washington on September 10th, 2002. The purpose of the workshop was to discuss the status of geologic mapping in the park and the associated bibliography for compiling both paper and digital maps, and to identify sources of available information and geologic resource management issues and needs. The workshop involved a half-day scoping session during which overviews of the NPS Inventory and Monitoring (I&M) program, the role of WASO-Geologic Resources Division (GRD) in overseeing the baseline inventory for geologic resources, and the on-going service-wide GRI were presented. The actions and products derived from this workshop include: (1) review and discuss geologic maps in the published record and current mapping in progress to determine which geologic maps will comprise the park's baseline inventory and be digitized into a GIS; (2) identify any new geologic mapping needs; (3) update and verify the bibliography; (4) write a summary report of the workshop (this report); and (5) write a Geologic Resources Evaluation Report which brings together all of these products.

Cooperators from the NPS Geologic Resources Division (GRD), LARO, the Pacific West Regional Office, Washington State DNR - Department of Geology and Earth Resources (DGER), USGS and Colorado State University were present for the workshop.

Overview of the Geologic Resources Evaluation

The NPS Geologic Resources Evaluation is a cooperative endeavor to implement a systematic, comprehensive inventory of the geologic resources in units of the National Park Service. It is one of twelve baseline Inventories of the NPS Inventory and Monitoring Program. For the 273 park units with significant natural resources, the GRE consists of four main activities and associated products:

1. **Compile a bibliography of geologic literature and maps.** Assemble a bibliography ("GRBIB") of known geological publications and compile and evaluate a list of existing geologic maps for each park,

    Geologic bibliographies are a subset of NPS "NRBIB" and are an attempt to locate all known park geologic references. These references are incorporated into the GRBIB website and distributed as Microsoft Access databases.

2. **Conduct an on-site workshop to evaluate park geologic maps, resources and issues and write a summary report (this document) for each park.**

    Workshops are held at parks to inventory and review available data on park geology and to discuss geologic issues. These workshops bring together park resource managers with geologists who are familiar with the park's geology who may come from the USGS, state, local or academic institutions. Weather permitting, there is usually a one-day fieldtrip, with a subsequent round-table discussion on the availability and quality of existing geologic information, including geologic maps, and park specific geologic resource issues and management, interpretive, and research needs.

3. **Develop digital geologic GIS data products with accompanying supporting information.**

    Digitizing geologic maps facilitates the incorporation of geologic considerations into a wide range of applications. The purpose of the GRE digital geologic mapping effort is to:

- Reveal existing known geologic map extent and scale;
- Acquire and evaluate known maps for usefulness of scale, quality and extent;
- Initiate digitizing of acceptable existing geologic maps and/or seek new field mapping projects to fill gaps in the map record;
- Attribute digital data per the NPS digital geologic model for service-wide digital standards and protocols.

4. Write a Geologic Resources Evaluation Report with basic information on geologic setting and history, geologic hazards, and other geologic related issues.

Park-specific geologic reports identify geologic features and processes that are important to park ecosystems and resource management, the impact human activities have on geologic features and processes, geologic research and monitoring needs, and opportunities for education and interpretation. In addition, geologic reports provide a brief geologic history of the park and address specific geologic formation properties, thus providing a critical link between the geologic map and the resource manager.

The emphasis of the inventory is not to routinely initiate new geologic mapping projects, but to aggregate existing "baseline" information and identify where serious geologic data needs and issues exist in the National Park System. In cases where map coverage is nearly complete (e.g. 4 of 5 quadrangles for Park "X"), or maps simply do not exist, then funding may be available for mapping the park's geology.

During the workshop Bruce Heise (NPS-GRD) presented overviews of the Geologic Resources Division, the NPS I&M Program, the status of the Natural Resource Inventories, and the Geologic Resource Inventory in particular. Joe Gregson (NPS-NRID) presented a demonstration of some of the main features and utility of a digital geologic database using the Black Canyon of the Gunnison NP (BLCA) and Curecanti NRA (CURE) in Colorado as an example. BLCA/CURE has become the prototype for the NPS digital geologic map model as it reproduces all aspects of a paper geologic map, including map notes, cross sections, lithologic columns and legend, with the added benefit of being geospatially referenced. It is displayed in ESRI ArcView shape files and features a built-in Microsoft Windows help file system to identify the map units. It can also display scanned JPG or GIF images of the geologic cross sections supplied with the paper "analog" map. Geologic cross section lines (e.g. A-A') are subsequently digitized as a line coverage and are hyperlinked to the scanned images.

GRBIB

During the workshop, individual Microsoft Word documents of Geologic Bibliographies for LARO were distributed. The sources for this complied information are as follows:

- AGI (American Geological Institute) GeoRef
- USGS GeoIndex
- ProCite information taken from specific NPS park libraries

These bibliographic compilations were validated by GRE staff to eliminate duplicate citations, typographical errors, and to check for applicability to the specific park. After validation, they become part of a Microsoft Access database parsed into columns based on park, author, year of publication, title, publisher, publication number, and a miscellaneous column for notes.

For the Access database, they are exported as Microsoft Word documents for easier readability, and eventually turned into PDF documents. These data are planned to be migrated into the NPS servicewide bibliographic website late in 2006 where they can be found at http://science.nature.nps.gov.im.

Geologic Resource-Related Management Issues and Needs

Lake Roosevelt is the largest storage reservoir on the Columbia River and in the U.S. The Grand Coulee Dam is managed and operated by the Bureau of Reclamation (BOR) for electrical power generation, flood control, and irrigation. Construction of the dam and filling of the reservoir significantly impacted historical fisheries, upon which indigenous peoples and their culture were dependent, as well as farming, ranching and logging. Seasonal fluctuation of the level of the reservoir resulting from operations at the dam aggravates shoreline erosion, which increases sediment loading in the reservoir; and periodically exposes the lake bed, which then becomes a sediment source for airborne dust. Some of this dust is toxic due to concentrations of heavy metal waste discharged into the Columbia River from smelter operations in Canada. Also, mines along the Spokane River in Idaho have contributed heavy metals, sometimes referred to as “exotic” metals, in various chemical speciations following geochemical release from their lithologic source (host rock or ore deposits). Regardless of the source and era of contamination, reservoir sediments remain a sink for the influx of heavy metals since the inception of mining and smelter operations within Lake Roosevelt’s watershed. Heavy metals are also known to bioaccumulate in the aquatic food web and are a know public health issue for those who regularly consume fish from the reservoir. During the 1980s public complaint concerning water quality led to upgrades in smelter operations and a reduction in discharge of heavy metals from Canadian ore processing operations. The Colville Tribal Environmental Trust Council has received Congressional funding for sediment transport research, and the USGS Water Resources Division has been studying heavy metal contamination of the lake bed sediments.

While there are known uranium mines on the Spokane Indian Reservation, it is unknown if they have or are contributing sediment, metal or radioactive contaminants into the reservoir.

The BOR has mapped most of Lake Roosevelt’s shoreline for glacial and sedimentary deposits and erosional features; staff geologists monitor the lakeshore for erosion of sedimentary deposits, since landslides are an issue for both the BOR and LARO. BOR has anchored logs along the shoreline as one mitigation measure, but has not consistently monitored and maintained them. Park managers would like to know how shoreline erosion might be affecting NPS geologic and archeological resources and if there is need for concern of associated geologic hazards. Basic questions are: “Are there public safety issues or hazards associated with shoreline slumping?” “Are we losing cultural and natural resources, such as paleontological and archeological site localities, and the sedimentary record of the glacial outburst floods, to erosion?” “What are suitable erosion mitigation techniques, especially to protect cultural sites?” While there are no known paleontologic resources at LARO, the potential has yet to be explored, and would probably be most associated with volcanic ash deposits.

Due to the foregoing issues, LARO managers are more interested in knowing about the park’s surficial geology and associated processes, such as erosion, and land sliding, and sediment transport than with bedrock geology. Sediment transport also relates to water resource issues affecting the mobility, chemical speciation, deposition, and residence time of heavy metals. Geologic maps that differentiate surficial deposits, rather than consolidating them into a few cover units, would provide greater value to LARO for management, resource stewardship, health and safety, and interpretive purposes. The park resource manager commented that the park archeologist would like very detailed site-specific geologic maps and innovative ideas on how to stabilize slopes around cultural sites without using a lot of riprap, and that park managers would like geologic issues and localities more closely assessed at the park with the result of informing managers about legitimate geologic-related concerns and mitigation strategies.

Review of Published Geologic Maps

Using the GRBIB bibliography for LARO, a search and reference list was made for any existing surficial and bedrock geologic maps covering LARO (Appendix C). From this search several index maps were created and distributed during the meeting that show the spatial layout of geologic map coverage at various scales for the park. These scales range from 1:250,000 down to 1: 2,400, and provide partial to complete coverage of the park. Also, the Washington DGER has an on-line geologic map index of their publications that includes a searchable bibliography. This database is available at http://www.dnr.wa.gov/geology/washbib.htm. Washington DGER also has the entire state's bedrock geology mapped at 1:100,000 and 1:250,000 scales, some of which was compiled from previous work done by the USGS. These maps are also available in digital form.

Maps smaller than 1:100,000-scale were not individually discussed during the meeting since this scale of mapping generally does not provide the level of detail and site specific information necessary to meet the "knowledge of resources" purposes of the GRI. The preferred map scale for the GRI is 1:24,000 (7 ½-minute quadrangles). But, these are not always available for complete coverage of a park. For larger parks, geology mapped on 15-minute quadrangles may be the preferred scale to meet the needs of the geologic baseline inventory.

Some meeting participants had direct or indirect knowledge about some of the larger scale geologic maps which aided our discussion in determining the appropriate maps, if any, to comprise the baseline geologic map inventory and coverage for the park. Some larger scale Washington DGER published maps were acknowledged to be old mapping, even if they have a more recent copyright date. It is not uncommon to have mapping done by professors and other geologists outside of DGER who then submit their work, sometimes decades later, for publication. Most of the larger scale published maps showed primarily bedrock geology, emphasizing mineral resources, with little mapping or differentiation of surficial geology.

Quadrangles of Interest

There are 58 7½-minute quadrangles of interest for LARO (see appendix A). These quads were identified by the park in the early 1990s for base cartography inventory and initially adopted by the geologic resource evaluation for query in identifying and obtaining baseline geologic information. It is not known if there is any active mapping occurring in any of these quads at this time. Only four quads are identified in the published database (Bangs Mountain, Boyd, Marcus and Kettle Falls). Currently, the state has no mapping projects in the LARO area, and no tentative plans. But, the state geologist expressed interest in mapping if funding was available.

Eugene Kiver and Dale Stradling, of Eastern Washington University, mapped much of the shoreline of Lake Roosevelt during the 1980s for the Bureau of Reclamation. Their 1:24,000-scale maps are in paper format and are part of an unpublished report submitted to the BOR in 1995. These maps have been used by BOR geologists as a geologic baseline for monitoring shoreline erosion and slope stability. Since 1:24,000-scale topographic maps for the state of Washington were not finished and published until the early 1990s, Kiver and Stradling enlarged several 15-minute scale topographic maps and cut them into quarters to obtain a simulation of "1:24,000" scale topographic maps. Twenty seven of these maps and 10 true 1:24,000 scale topographic maps comprise their map set and correspond with 37 of the park's 58 quadrangles of interest (see appendix B).

The geologic mapping done by Kiver and Stradling emphasized surficial deposits and features along the flooded valleys of the Columbia River and its tributaries from the Grand Coulee Dam to the Canadian border. Their map units consist of three symbols that identify (1) geologic era or period, (2) lithology, and (3) sediment texture (e.g. boulder, cobble, pebble, gravel, mixed, sand, slit, clay, interbedded or undifferentiated). For Quaternary-aged map units, instead of lithology the second identifier in the unit name indicates the geologic process or environment that controlled the type of sediment that was deposited, such as eolian, outwash, flood, glacial, lacustrine, till, alluvial, landslide, or artificial. Some of these units are further differentiated into age of glaciation or type of slope failure deposit (e.g. slump, flow, talus, rock slide). The geologic maps produced by Kiver and Stradling contain a lot of information about processes or events that deposited a variety of unconsolidated sediments along the Columbia River, and contemporary processes operating on these sediments. The detailed geologic information contained on these maps is invaluable for the resource management of this predominantly shoreline park, especially in consideration of seasonal fluctuations in the water level of the reservoir associated with operations of Grand Coulee Dam.

Three of these maps were brought to the meeting and reviewed by the participants. Both LARO and the BOR are interested in having all 37 of the maps by Kiver and Stradling digitized, and there was ready concurrence by several of the other participants, with recognition that the maps will require substantial interpretation in the digitizing process to make coverages out of them. Others expressed that they would like to see more bedrock information, but this would have to come from smaller-scale maps or new geologic mapping.

2006 Update

Since this GRE scoping meeting a geologic GIS specialist has come on staff at the Pacific West Regional Office in Seattle for the purpose of converting paper geologic maps into a digital database. The BOR has sent paper copies of the maps by Kiver and Stradling to this office for review and converting into a GIS. These paper maps are black and white copies that are difficult to distinguish contacts from contours, especially where contours are closely spaced. Further there are georeferencing issues since 27 of the 37 7.5 minute quads are actually enlarged and quartered 15-minute quads that are missing georeference tic marks on one or more edges. Also, it is not known how these copies were reproduced, by scanning or photocopying. If the latter, then these copies will probably also be distorted. The only way to georeference these maps will be by an overlay comparison relative to the DRGs. Presently these maps are in a queue of other parks' maps and are scheduled to be converted in FY08. Prior to this the PWRO geologic GIS specialist intends to consult with Kiver and/or Stradling, and possibly obtain color scans of their maps, to resolve the geology and georeferencing issues.

References

Kiver, Eugene P. and Dale F. Stradling, 1995, Geology of the Franklin D. Roosevelt Reservoir Shoreline: Glacial Geology, Terraces, Landslides, and Lineaments, USDOI, Bureau of Reclamation, Grand Coulee Power Office, unpublished report, 148 p.

Scoping Meeting Participants

Tim Connors	Geologist	NPS, Geologic Resources Division
Craig Dalby	GIS Coordinator	NPS, Pacific West Region
Marsha Davis	Geologist	NPS, Pacific West Region
John Graham	Geologist	Colorado State University cooperator
Joe Gregson	Physical Scientist	NPS, Natural Resources Information Division
Ralph Haugerud	Geologist	USGS, Seattle
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Bruce Heise	Geologist	NPS, Geologic Resources Division
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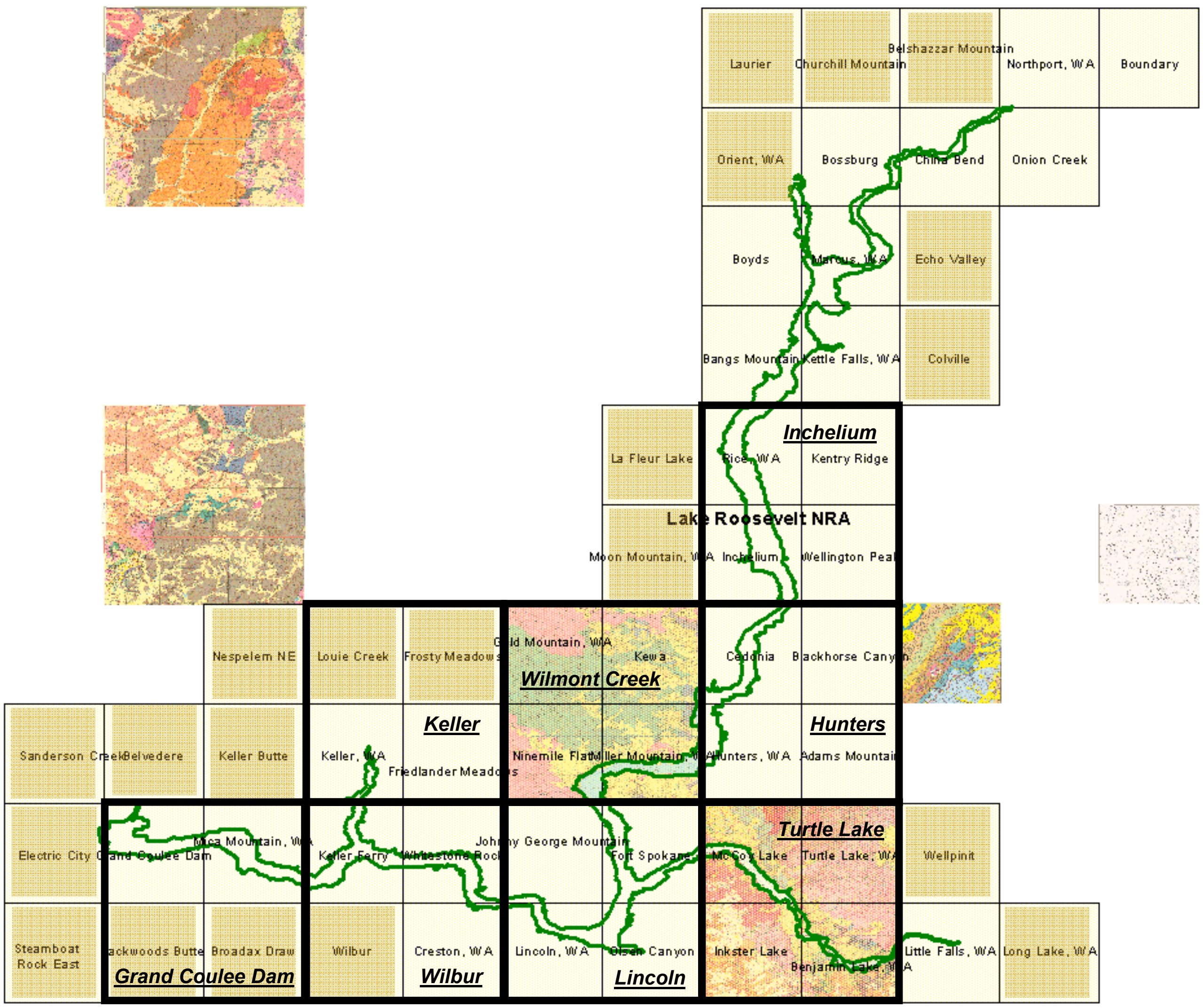
Appendix A

LARO 7.5-minute quadrangles of interest (58)



Kiver and Stradling mapped geology on ten 7.5-minute quadrangles (not shaded) and enlarged and cut into quarters eight 15-minute quadrangles (outlined), 27 of which were mapped. Twenty one 7.5-minute quadrangles of the fifty eight quadrangles of interest for Lake Roosevelt NRA were not mapped (shaded).

Appendix B

LARO Geologic Map Quadrangles of Interest mapped by Kiver and Stradley (1995) for the BOR

7 ½ -minute and 15-minute Quadrangle names covering LARO from Coulee Dam upriver to the Canadian border

	True 7 ½-minute Quad	True 15-minute Quad	Kiver & Stradling 7 ½-minute Quad
1	*(Grand Coulee Dam)*	Grand Coulee Dam	**Grand Coulee Dam NW**
2	*(Mica Mountain)*	Grand Coulee Dam	**Grand Coulee Dam NE**
3	*(Keller Ferry)*	Wilbur	**Wilbur NW**
4	*(Keller)*	Keller	**Keller SW**
5	*(Whitestone Rock)*	Wilbur	**Wilbur NE**
6	*(Creston)*	Wilbur	**Wilbur SE**
7	*(Friedlander Meadows)*	Keller	**Keller SE**
8	*(Johnny George Mountain)*	Lincoln	**Lincoln NE**
9	*(Lincoln)*	Lincoln	**Lincoln SW**
10	*(Fort Spokane)*	Lincoln	**Lincoln NW**
11	*(Olsen Canyon)*	Lincoln	**Lincoln SE**
12	*(McCoy Lake)*	Turtle Lake	**Turtle Lake NE**
13	*(Inkster Lake)*	Turtle Lake	**Turtle Lake SW**
14	*(Turtle Lake)*	Turtle Lake	**Turtle Lake NW**
15	*(Benjamin Lake)*	Turtle Lake	**Turtle Lake SE**
16	Little Falls	*Wellpinit*	Little Falls
17	*(Ninemile Flat)*	Wilmont Creek	**Wilmont Creek SW**
18	*(Miller Mountain)*	Wilmont Creek	**Wilmont Creek SE**
19	*(Hunters)*	Hunters	**Hunters SW**
20	*(Adams Mountain)*	Hunters	**Hunters SE**
21	*(Cedonia)*	Hunters	**Hunters NW**
22	*(Blackhorse Canyon)*	Hunters	**Hunters NE**
23	*(Kewa)*	Wilmont Creek	**Wilmont Creek NE**
24	*(Gold Mountain)*	Wilmont Creek	**Wilmont Creek NW**
25	*(Inchelium)*	Inchelium	**Inchelium SW**
26	*(Wellington Peak)*	Inchelium	**Inchelium SE**
27	*(Rice)*	Inchelium	**Inchelium NW**
28	*(Kentry Ridge)*	Inchelium	**Inchelium NE**
29	Bangs Mountain	Kettle Falls	Bangs Mountain
30	Kettle Falls	Kettle Falls	Kettle Falls
31	Marcus	Kettle Falls	Marcus
32	Boyds	Kettle Falls	Boyds
33	Bossburg	Orient	Bossburg
34	China Bend	NA	China Bend
35	Onion Creek	NA	Onion Creek
36	Northport	NA	Northport
37	Boundary	NA	Boundary

7 ½-minute quadrangle names italicized and shown in parenthesis (column 1) were not available as topographic maps at the time Kiver and Stradling mapped the geology of the LARO area. For these quadrangles Kiver and Stradling enlarged the 15-minute topographic quads and cut them into quarters for their use in the field. These quartered quads are identified in bold font in column 3.

Appendix C

Published geologic map citations for Lake Roosevelt National Recreation Area

Full Citation	GRE Gmap id	Scoped	Digitize for Baseline Inventory
Babcock, L., Beck, P., Farley, W., Lechler, P., Lindgren, J., Miller, D., Pigott, J., and Sayala, D., 1981, An exploration systems approach to the Spokane Mountain area uranium deposits, northeastern Washington [Plate 1], US Department of Energy, unknown,	1995	yes	no
Gardner, J.N and Wright, T.L., 1979, Reconnaissance geologic map of the Columbia River Basalt Group in eastern Washington and northern Idaho, USGS, OF-79-1363, 1:250000 scale	2051	yes	no
Griggs, A.B., 1973, Geologic map of the Spokane quadrangle, Washington, Idaho, and Montana, USGS, I-768, 1:250000 scale	2050	yes	no
Hanson, L.G., 1979, Surficial geologic map of the Okanogan quad, Washington, Washington Division of Geology and Earth Resources, OF-79-7, 1:250000 scale	2049	yes	no
Hanson, L.G., Kiver, E.P., Rigby, J.G., and Stradling, D.F., 1979, Surficial geologic map of the Ritzville quad, Washington, Washington Division of Geology and Earth Resources, OF-79-10, 1:250000 scale	2048	yes	no
Kiver, E.P., Rigby, J.G., and Stradling, D.F., 1979, Surficial geologic map of the Spokane quad, Washington, Washington Division of Geology and Earth Resources, OF-79-11, 1:250000 scale	2047	yes	no
Campbell, C.D., 1946, Lead-zinc deposits in part of the Northport district, Wash. [Plate 1], USGS, OF, 1:125000 scale	2046	yes	no
Griggs, A.B., 1966, Reconnaissance geologic map of the west half of the Spokane quadrangle, Idaho and Washington, USGS, I-464, 1:125000 scale	2045	yes	no
Miller, F.K. and Yates, R.G., 1976, Geologic map of the west half of the Sandpoint 1[degree] X 2[degree] quadrangle, [Washington, Idaho], USGS, OF-76-327, 1:125000 scale	2044	yes	no
Yates, R.G., 1976, Geology of the Deep Creek area, Washington, and its regional significance, USGS, OF-76-537, 1:31680 scale	1992	yes	no
Becraft, G.E. and Weis, P.L., 1957, Preliminary geologic map of part of the Turtle Lake quadrangle, Lincoln and Stevens Counties, Washington, USGS, MF-135, 1:48000 scale	1997	yes	no
Smith, M.T., 1991, Geologic strip map of the Ninemile Creek-Wilmont Creek-Hunters area, Ferry and Stevens Counties, Washington, Washington Division of Geology and Earth Resources, OF-91-4, 1:24000 scale	1984	yes	no
Wilson, J.R, 1981, Geologic map of the Bangs Mountain quadrangle, Ferry and Stevens Counties, Washington, USGS, OF-81-581, 1:24000 scale	1985	yes	no
Wilson, J.R., 1980, Preliminary geologic map of the Boyds quadrangle, Ferry and Stevens Counties, Washington, USGS, OF-80-983, 1:24000 scale	1986	yes	no
Yates, R.G. and Robertson, J.F., 1958, Preliminary geologic map of the Leadpoint quadrangle, Stevens County, Washington, USGS, MF-137, 1:24000 scale	1987	yes	no
Yates, R.G. and Ford, A.E., 1960, Preliminary geologic map of the Deep Lake quadrangle, Stevens and Pend Oreille Counties, Washington, USGS, Map MF-237, 1:24000 scale	1988	yes	no
Yates, R.G., Miller, F.K., Marshall, B.V., and Baker, D.W., 1969, Geologic map of the North Port quadrangle, Washington, USGS, OF-69-324, 1:31680 scale	1989	yes	no
Mills, J.W., 1985, Geologic maps of the Marcus and Kettle Falls quadrangles, Stevens and Ferry Counties, Washington, Washington Division of Geology and Earth Resources, GM-32, 1:24000 scale	1982	yes	no
Yates, R.G., 1971, Geologic map of the Northport quadrangle, Washington, USGS, I-603, 1:31680 scale	1991	yes	no
McLucas, G.B., 1980, Surficial geology of the Springdale and Forest Center quadrangles, Stevens County, Washington, Washington Division of Geology and Earth Resources, OF-80-3, 1:24000 scale	1981	yes	no
Campbell, Ian and Loofbourow, J.S., 1957, Preliminary geologic map and sections of the magnesite belt, Stevens County, Washington, USGS, MF-117, 1:36000 scale	1993	yes	no
Campbell, Ian and Loofbourow, J.S., 1962, Geology of the magnesite belt of Stevens County, Washington, USGS, Bulletin 1142-F, 1:36000 scale	1994	yes	no
Weaver, C.E., 1920, The mineral resources of Stevens County, Washington Geological Survey, Bulletin 20, 1:125000 scale	2043	yes	no
Schuster, J.E., 1976, Geology of the Clugston Creek area, Stevens County, Washington, Washington Division of Geology and Earth Resources, OF-76-8, 1:37500 scale	1996	yes	no
Becraft, G.E., 1964, Preliminary geologic map of the Wilmont Creek quadrangle, Ferry and Stevens Counties, Washington, USGS, MF-283, 1:48000 scale	1998	yes	no
Rinehart, C.D. and Fox, K.F., 1994, Geologic map of the Aeneas Valley quadrangle, Okanogan County, Washington, USGS, OF-93-709, 1:48000 scale	1999	yes	no
Pearson, R.C., 1977, Preliminary geologic map of the Togo Mountain quadrangle, Berry County, Washington, USGS, OF-77-371, 1:48000 scale	2000	yes	no
Yates, R.G., 1964, Geologic map and sections of the Deep Creek area, Stevens and Pend Oreille Counties, Washington, USGS, I-412, 1:31680 scale	1990	yes	no

Full Citation	GRE Gmap id	Scoped	Digitize for Baseline Inventory
Stensgar Mountain, 1982, Preliminary geologic map of the Stensgar Mountain quadrangle, Stevens County, Washington, USGS, OF-82-492, 1:24000 scale	1973	yes	no
Cambell, C.D., 1946, Lead-zinc deposits in part of the Northport district, Wash. [Plate 6], USGS, OF, 1:2400 scale	1964	yes	no
Deiss, Charles, 1955, Dolomite deposit near Marble, Stevens County, Washington, USGS, Bulletin 1027-C, 1:2400 scale	1965	yes	no
Campbell, C.D., 1949, Geology of the Bechtol lead mine, Stevens County, Washington, USGS, OF-Plate 2, 1:12000 scale	1966	yes	no
Campbell, C. D., 1946, Lead-zinc deposits in part of the Northport district, Wash. [Plate 2], USGS, OF, 1:12000 scale	1967	yes	no
Campbell, C.D., 1946, Lead-zinc deposits in part of the Northport district, Wash. [Plate 3], USGS, OF, 1:12000 scale	1968	yes	no
Nash, J. T., 1977, Geology of the Midnite uranium mine area, Washington -- maps, description, and interpretation, USGS, OF-77-592, 1:12000 scale	1969	yes	no
Smith, M.T., 1991, Geologic map of the Old Copper Hill -Butcher Mountain area, Stevens County, Washington, USGS, OF-91-6, 1:12000 scale	1970	yes	no
Mills, J.W., Duncan, G.W., Brainard, R.C., Hogge, C.E., and Laskowski, E.R., 1985, Geologic maps of the Echo Valley and the north part of the Colville 7 1/2-minute quadrangles, Washington, Washington Division of Geology and Earth Resources, OF-85-7, 1:240	1983	yes	no
Yates, R.G, 1956, Geologic map of the Leadpoint quadrangle, Washington, USGS, OF-56-367, 1:20000 scale	1971	yes	no
Fox, K.F., 1978, Geologic map of the Mt. Bonaparte quadrangle, Okanogan County, Washington, USGS, OF-78-732, 1:48000 scale	2003	yes	no
Fox, K.F., 1981, Reconnaissance geologic map of Churchill Mtn. quadrangle, Stevens County, Washington, USGS, OF-81-169, 1:24000 scale	1974	yes	no
Lindsey, K.A, 1988, Geology of parts of the Upper Proterozoic to Lower Cambrian Three Sisters Formation, Gypsy Quartzite, and Addy Quartzite, Stevens and Pend Oreille Counties, northeastern Washington [Plate 1], Washington Division of Geology and Earth Re	1975	yes	no
Lindsey, K.A., 1988, Geology of parts of the Upper Proterozoic to Lower Cambrian Three Sisters Formation, Gypsy Quartzite, and Addy Quartzite, Stevens and Pend Oreille Counties, northeastern Washington [Plate 2], Washington Division of Geology and Earth R	1976	yes	no
Clark, L.D. and Miller, F.K., 1965, Preliminary geologic map of the Chewelah district, Stevens County, Washington, USGS, OF-65-32, 1:24000 scale	1977	yes	no
Carrara, P.E., 1990, Preliminary surficial geologic map of the Chewelah quadrangle, Stevens County, Washington, USGS, MF-2141, 1:24000 scale	1978	yes	no
Lindsey, K.A., 1988, Geology of parts of the Upper Proterozoic to Lower Cambrian Three Sisters Formation, Gypsy Quartzite, and Addy Quartzite, Stevens and Pend Oreille Counties, northeastern Washington [Plate 4], Washington Division of Geology and Earth R	1979	yes	no
Lindsey, K.A., 1988, Geology of parts of the Upper Proterozoic to Lower Cambrian Three Sisters Formation, Gypsy Quartzite, and Addy Quartzite, Stevens and Pend Oreille Counties, northeastern Washington [Plate 5], Washington Division of Geology and Earth R	1980	yes	no
Evans, J.G, 1987, Geology of the Stensgar Mountain Quadrangle, Stevens County, Washington, USGS, Bulletin 1679, 1:24000 scale	1972	yes	no
Joseph, N.L., 1990, Geologic map of the Colville 1:100,000 quadrangle, Washington-Idaho, Washington Division of Geology and Earth Resources, OF-90-13, 1:100000 scale	2033	yes	no
Weaver, C.E., 1913, Geology and ore deposits of the Covada mining district, Washington Division of Geology and Earth Resources, Bulletin 16, 1:63360 scale	2024	yes	no
Moen, W.S., 1980, Myers Creek and Wauconda mining districts of northeastern Okanogan County, Washington [Plate 1}, Washington Division of Geology and Earth Resources, Bulletin 73, 1:80000 scale	2025	yes	no
Campbell, C.D., 1947, Cambrian rocks of northeastern Stevens County, Washington, Geological Society of America, Bulletin v. 58, p. 597-612, Plate 1, 1:95040 scale	2026	yes	no
Waggoner, S.Z., 1990, Geologic map of the Coulee Dam 1:100,000 quadrangle, Washington, Washington Division of Geology and Earth Resources, OF-90-15, 1:100000 scale	2027	yes	no
Waggoner, S.Z., 1990, Geologic map of the Chewelah 1:100,000 quadrangle, Washington-Idaho, Washington Division of Geology and Earth Resources, OF-90-14, 1:100000 scale	2028	yes	no
Stoffel, K.L., 1990, Geologic map of the Republic 1:100,000 quadrangle, Washington, Washington Division of Geology and Earth Resources, OF-90-10, 1:100000 scale	2029	yes	no
Miller, F.K., 2000, Geologic map of the Chewelah 30' X 60' quadrangle, Washington and Idaho, USGS, MF-2354, 1:100000 scale	2030	yes	no
Miller, F.K., 1996, Geologic map of the Empey Mountain area, Stevens County, Washington, USGS, I-2493, 1:48000 scale	2001	yes	no
Joseph, N.L., 1990, Geologic map of the Nespelem 1:100,000 quadrangle, Washington, Washington	2032	yes	no

Full Citation	GRE Gmap id	Scoped	Digitize for Baseline Inventory
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Staatz, M.H., 1964, Geology of the Bald Knob quadrangle, Ferry and Okanogan Counties, Washington, USGS, Bulletin 1161-F, 1:62500 scale	2021	yes	no
Miller, F.K., Clark, L.D., and Engels, J.C., 1975, Geology of the Chewelah-Loon Lake area, Stevens and Spokane Counties, Washington with a section on potassium-argon ages of the plutonic rocks, USGS, PP 806, 1:62500 scale	2019	yes	no
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Gulick, C.W. and Korosec, M.A., 1990, Geologic map of the Omak 1:100,000 quadrangle, Washington, Washington Division of Geology and Earth Resources, OF-90-12, 1:100000 scale	2036	yes	no
Gulick, C.W. and Korosec, M.A., 1990, Geologic map of the Banks Lake 1:100,000 quadrangle, Washington, Washington Division of Geology and Earth Resources, OF-90-6, 1:100000 scale	2037	yes	no
Embrey, S.S., Hansen, A.J., and Cline, D.R., 1997, Groundwater resources of three areas on the Spokane and Kalispell Indian Reservations, northeastern Washington [Spokane Indian Reservation], USGS, Water-Resources Report 94-4235, 1:100000 scale	2038	yes	no
Carrara, P.E., Kiver, E.P., and Stradling, D.F., 1995, Surficial geologic map of the Chewelah 30' X 60' quadrangle, Washington and Idaho, USGS, I-2472, 1:100000 scale	2039	yes	no
Joseph, N.L., 1990, Geologic map of the Spokane 1:100,000 quadrangle, Washington-Idaho, Washington Division of Geology and Earth Resources, OF-90-17, 1:100000 scale	2031	yes	no
Clark, L.D. and Miller, F.K., 1968, Geology of the Chewelah Mountain quadrangle, Stevens County, Washington, Washington Division of Mines and Geology, GM-5, 1:62500 scale	2012	yes	no
Atwater, B.F. and Rinehart, C.D., 1984, Preliminary geologic map of the Colville Indian Reservation, Ferry and Okanogan Counties, Washington, with a table of potassium-argon ages compiled by Robert J. Fleck, USGS, OF-84-389, 1:100000 scale	2041	yes	no
Carlson, D.H., 1993, Geology and geochemistry of the Coulee Dam intrusive suite and associated younger intrusive rocks, Colville batholith, Washington, USGS, Bulletin 1846, 1:48000 scale	2004	yes	no
Campbell, A.B. and Raup, O.B., 1964, Preliminary geologic map of the Hunters quadrangle, Stevens and Ferry Counties, Washington, USGS, MF-276, 1:48000 scale	2005	yes	no
Calkins, J.A., Parker, R.L., and Disbrow, A.E., 1959, Geologic map of the Curlew quadrangle, Ferry County, Washington, USGS, OF-59-15, 1:48000 scale	2006	yes	no
Snook, J.R., Campbell, A.B., Lucas, H.E., Abrams, M.J., Janzen, John, and Smith, Bruce, 1990, Geologic map of the Inchelium quadrangle, Stevens and Ferry Counties, Washington, USGS, MF-1752, 1:48000 scale	2007	yes	no
Rinehart, C.D. and Greene, R.C., 1988, Geologic map of the northwestern three-fourths of the Aeneas quadrangle, Okanogan and Ferry Counties, Washington, USGS, OF-88-281, 1:48000 scale	2008	yes	no
Muessig, Siegfried and Quinlan, J. J., 1959, Geologic map of the Republic and part of the Wauconda quadrangles, Washington, USGS, OFR-59-88, 1:62500 scale	2009	yes	no
Umpleby, J.B., 1911, Part I--Geology and ore deposits of the Myers Creek mining district; Part II--Geology and ore deposits of the Oroville-Nighthawk mining district [Plate I], Washington Geological Survey, Bulletin 5, 1:63360 scale	2023	yes	no
Cruson and Pansze, 1980, Geologic study of Kettle dome, northeast Washington--Final report:, US Department of Energy, unknown, 1:62500 scale	2011	yes	no
Umpleby, J.B., 1910, Geology and ore deposits of Republic mining district, Washington Geological Survey, Bulletin 1 Bulletin 1, 1:63360 scale	2022	yes	no
Campbell, C.D., Thorsen, G.W., and Livingston, V.E., Jr., 1980, Geology of the Sherman Peak and west half of the Kettle Falls quadrangles, Ferry County, Washington; rev., Washington Division of Geology and Earth Resources, OF- 75-3, 1:62500 scale	2013	yes	no
Becraft, G.E. and Weis, P.L., 1963, Geology and mineral deposits of the Turtle Lake quadrangle, Washington, USGS, Bulletin 1131, 1:62500 scale	2014	yes	no
Becraft, G.E., 1966, Geologic map of the Wilmont Creek quadrangle, Ferry and Stevens Counties, Washington, USGS, GQ-538, 1:62500 scale	2015	yes	no
Pearson, R.C., 1967, Geologic map of the Bodie Mountain quadrangle, Ferry and Okanogan Counties, Washington, USGS, GQ-636, 1:62500 scale	2016	yes	no
Parker, R.L. and Calkins, J.A., 1964, Geology of the Curlew quadrangle, Ferry County, Washington, USGS, Bulletin 1169, 1:62500 scale	2017	yes	no
Muessig, Siegfried, 1967, Geology of the Republic quadrangle and a part of the Aeneas quadrangle, Ferry County, Washington, USGS, Bulletin 1216, 1:62500 scale	2018	yes	no
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Fox, K.F. and Becraft, G.E., 1994, Geologic map of the Twin Lakes 15' quadrangle, Ferry County, Washington, USGS, OF-93-715, 1:62500 scale	2010	yes	no
Swanson, D.A., Bentley, R.D., Byerly, G.R., Gardner, J.N., and Wright, T.L., 1979, Preliminary reconnaissance geologic maps of the Columbia River Basalt Group in part of eastern Washington and northern Idaho, USGS, OF-79-534, 1:250000 scale	2056	yes	no
Stoffel, K.L., Joseph, N.L., Waggoner, S.Z., Gulick, C.W., Korosec, M.A., and Bunning, B.B., 1991, Geologic map of Washington- northeast quadrant, Washington Division of Geology and Earth Resources, GM-39, 1:250000 scale	2057	yes	no
Lenfesty, C. D., 1980, Soil survey of Okanogan County area, Washington, unknown, unknown, 1:20000 scale	3169	yes	no
Pardee, J.T. and Bryan, Kirk, 1926, Geology of the Latah Formation in relation to the lavas of Columbia Plateau near Spokane, Washington, USGS, PP 140, 1:250000 scale	2055	yes	no
Pardee, J.T., 1918, Geology and mineral deposits of the Colville Indian Reservation, Washington, USGS, Bulletin 677, 1:250000 scale	2054	yes	no
Miller, F.K., Burmester, R.F., Powell, R.E., Miller, D.M., and Derkey, P.D., 1999, Digital geologic map of the Sandpoint 1 degree X 2 degree quadrangle, Washington, Idaho, and Montana, USGS, OF-99-144, 1:250000 scale	2053	yes	no
Aadland, R.K. and Bennett, E.H., 1979, Geologic map of the Sandpoint quadrangle, Idaho and Washington, Idaho Geological Survey, GM-16, 1:250000 scale	2052	yes	no
Boleneus, D.E. and Causey, J.D., 2000, Geologic datasets for weights of evidence analysis in northeast Washington - 1. geologic raster data, USGS, OF-00-495, 1:100000 scale	2040	yes	no
Campbell, C.D., 1946, Lead-zinc deposits in part of the North port district, Wash. [Plate 5], USGS, OF, 1:12000 scale	2058	yes	no